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Fresh fruits, vegetables and mushrooms as transmission vehicles for *Echinococcus multilocularis*

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In their recent article, Lass et al., (2015) found significant evidence for contamination of fresh fruits, vegetables and mushrooms with eggs of *Echinococcus multilocularis*. However, Robertson et al. (2016) were somewhat skeptical of their findings and questioned the plausibility of the extent and intensity of this contamination.

In studies in a highly endemic area for *E. granulosus* in Kazakhstan, we isolated *E. granulosus* eggs (confirmed by PCR) from 5 of 120 soil samples around rural dwelling and from vegetable gardens (Shaikenov et al., 2004). This was in an area where 5-23% of dogs are infected with *E. granulosus* (Torgerson et al., 2003). We did not estimate the detection limit of our technique so it is difficult to compare directly with Lass et al (2015) but it demonstrates that there can be widespread environmental contamination and hence a dispersal mechanism from dog faeces. Furthermore, when we undertook this study the prevalence of *E. granulosus* in dogs was lower than the prevalence of *E. multilocularis* in foxes in the study region reported by Lass et al. (2015), although potential level of egg contamination of the environment is difficult to compare as it will depend on the intensity of infection in definitive hosts and the population density of these hosts.

Robertson et al. (2016) also suggest that the high number of environmental samples positive for *E. multilocularis* is unreliable because of the low number of human alveolar echinococcus (AE) cases. Lass et al. (2016) argued that their results are credible because of the focal distribution of highly infected foxes, and notification of human cases, and the relative resistance of humans to this disease. However, it is also necessary to further consider the latent period between infection and clinical disease. Human AE cases reported now result from infection perhaps 10-15 years ago, so any risk from high environmental contamination observed now, might only become apparent some time in the future. This should be viewed in the context of increasing fox populations. Unfortunately human disease incidence can change quickly. In Kyrgyzstan human AE was rarely reported 15 years ago. Now there appears to be a major epidemic with 148 cases of AE notified in 2013, with an exponential increase in cases year by year (Raimkylov et al., 2015; Usubalieva et al., 2013) . Again the two countries might not be comparable as it is possible the human AE epidemic in Kyrgyzstan may be associated with widespread infection of dogs with *E. multilocularis* which have a closer contact with humans compared to foxes (Torgerson, 2013) which may not be the case in Poland.

Taeniid eggs can disperse widely in the environment. This is illustrated in old literature detailing recovery of viable eggs of *Taenia saginata* and *T. pisiformis* from bird faeces following the feedings of proglottids to these birds (Silverman and Griffiths, 1955). Dispersal over considerable distances is illustrated by the observation of infections of feral sheep with cysticerci of *T. hydatigena* on the island archipelago of St Kilda, off the west coast of Scotland (Torgerson et al., 1995). This is despite the complete absence of dogs on these islands as the human population (and associated domestic dogs) were evacuated in the 1930s. It was speculated that birds may be transferring viable taeniid eggs from the Scottish mainland – a distance of some 60 km.

But of greater pertinence to the current debate are the results of Lawson and Gemmell (1990) who demonstrated the dispersal ability of *T. hydatigena* eggs from experimentally infected dogs to neighboring lambs even though there was no direct contact between the two. Experiments demonstrated that viable *Taenia* eggs could be recovered from blowflies which fed on dog faeces and, if these flies were fed to sheep, viable *T. hydatigena* cysts could be recovered from the sheep. Furthermore, when captive blowflies were exposed first to dog faeces containing proglottids of *T. hydatigena* and subsequently to cooked meat, 100% of pigs fed on this meat became infected (Lawson and Gemmell, 1990). Thus, in contrasts to the contention by Robertson et al. (2016) raspberries would not need to be at ground level to be contaminated with *Echinococcus* eggs if this mechanism is invoked, particularly since samples taken by Lass et al (2015) were from areas of high fox density. Although Lass et al., (2016) were aware of a problem regarding the mechanism of transmission to hanging fruit and hence took raspberries from a low level, it would be possible for insects to contaminate the fruits high up on the raspberry bushes.

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